

## Building Science and Performance Benefits

### Energy Efficiency

Typical homes in Connecticut were built to meet building codes without adequate attention to the ability of the exterior wall and ceiling assemblies to control heat loss and moisture levels. The result is homes that cost a great deal more to heat and cool than is necessary, not to mention the moisture related problems that can occur. At BPC, we address several key areas in order to build our energy efficient homes:

- **Foundations** are insulated, and basements are brought into the conditioned envelope. Surprisingly, this reduces total energy usage while providing a large additional area of dry, usable space.
- **Outside walls** are framed using techniques that allow a higher percentage of the wall to be insulated than is usually the case. Standard framing practices put more wood in the wall than is necessary and create corners and intersections that are impossible to insulate.
- **Air-tight insulated windows** are specified, with an argon gas fill between the panes of glass to slow convective heat loss, and low-e coatings on the glass itself to reflect the sun's heat during the summer and to reflect interior heat (from occupants and objects) during the winter.
- **Insulation** plays an important role in reducing heat loss. We use a variety of insulation products in order to provide the best possible thermal barrier for each situation. Products we use include blown/batt fiberglass, blown/damp spray cellulose, open/closed cell spray foams, rigid board foams, and mineral wool.
- **Air infiltration** through the exterior walls and ceiling is responsible for about 20-50% of the energy required to heat most homes. At BPC, we use a variety of special air-sealing techniques to eliminate most of this heat loss.
- **Duct leakage** allows 20-40% of the conditioned air in a typical house (with ducts installed in unconditioned basements and attics) to be lost. At BPC, we design and install air-tight duct systems within the conditioned envelope, eliminating this source of heat loss.
- **Free solar heating** is possible when new homes are designed with windows facing south. Passive solar heat has been used to heat homes since the time of the ancient Greeks, requires no technology, and can provide a meaningful amount of heat energy during the cold months.
- **Heating and cooling systems** can be downsized because the strategies listed above save so much energy. These systems are small and highly efficient, consuming much less energy than is typical for a home of a similar size.

### Comfort

Comfort occurs in a home with a stable air temperature that does not vary by more than three degrees, no matter where you go in the house; where there are no drafts or cold surfaces; and where the relative humidity is never too high in the summer or too low in the winter. Comfort is an important benefit of using residential building science to guide the construction of a house and is dependent upon the quality of the exterior envelope of the home and the HVAC mechanical system. This involves improvements to the framing, the insulation, and the air sealing, which result in the following comfort benefits:

- **Warm exterior walls**, without drafts and radiant heat loss. A room with warm air but cold walls may feel cold due to radiant heat loss from your body to the cold walls and windows. (The same principle allows a room with cool air but radiant heat in the floor to feel comfortable.)

#### BPC Green Builders, LLC

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- **Stable air temperatures** from floor to ceiling and between floors are produced by cutting heat loss and by using small, high efficiency heating and cooling systems that run continuously while using less energy.
- **A comfortable relative humidity (RH) in winter** is achieved without humidification. Typical home activities often generate adequate moisture to maintain a comfortable RH in an air-tight house, like those built by BPC. (Dry winter air is almost always a symptom of moisture loss via air leakage through the exterior envelope of the house.)
- **A comfortable relative humidity in summer** is achieved by using small, high efficiency air conditioning equipment, which is more effective at removing moisture than larger units. Central dehumidification is another option to expand the number of days when the RH can be reduced to optimal levels.
- **Sound transmission** from outside sources is reduced with an air-tight, well insulated exterior envelope. Sound transmission within the house can be reduced, as well, by using specially designed wall and floor assemblies.
- **Abundant, natural daylight**, especially in the winter, (without unwanted summer heat gain) is possible by carefully selecting window locations and glazing and by using appropriate roof overhangs.

### Indoor Air Quality

Many people don't realize that their home can impact many respiratory, neurological, and allergy related medical conditions. With the proper application of building science and careful materials specifications, the symptoms associated with these conditions can be controlled.

"Build tight and ventilate right" is both the primary solution to these problems as well as a guiding theme of residential building science. All of the new homes built by BPC are designed with waterproof foundations, conditioned basements, air-tight exterior envelopes, and mechanical ventilators that work 24/7 to reduce or eliminate a home's potential harmful effects on its occupants. These principles are endorsed by the American Lung Association, the National Association of Home Builders, the U.S. Environmental Protection Agency, and every other building organization in the country.

A few of the many healthier options offered by BPC are listed below.

- **Certified healthy** - BPC built an American Lung Association Health House in 2000, the only home in Connecticut to meet the program's rigorous standards.
- **Fresh ventilation air** - Mechanical ventilation of the living space is essential. Options range from a simple fresh air duct tied into a forced air heating/cooling system to the very best system, an energy recovery ventilator (ERV), which provides fresh air while transferring heat and moisture to maximize both comfort and efficiency.
- **Effective air filters** - A variety of effective filters for the very small dust particles that affect the respiratory system, as well as for airborne viruses and household odors.
- **Humidity and temperature control** - Central dehumidification and/or a properly sized cooling system will keep the relative humidity below the threshold level that dust mites and microbials need to thrive.
- **Vacuum options** - A portable vacuum (unless equipped with effective filtration) can recirculate the smallest dust particles back into the air. A central vacuum will capture the very small particles that most seriously affect the respiratory tract and exhaust them safely outdoors.

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- **Flooring options** - Numerous hard-surface flooring alternatives are available to eliminate the need for carpeting, a measure often recommended to those with asthma, respiratory or chemical sensitivity conditions.
- **Building products** – There is increasing availability of building materials and finishes that are formulated without the use of standard formaldehyde-based adhesives and other potentially dangerous chemicals.

## Safety

The typical new home today is subject to a variety of safety concerns. Listed below are some of the common construction defects that can have dangerous consequences:

- **Damp foundations** are often the result of hidden construction shortcuts, such as damp-proofing instead of waterproofing the walls, not providing adequate drainage for the footings and the gutters, and not using “free-draining” backfill against the walls.
- **Elevated radon levels** – Because Connecticut is subject to high levels of radon in the ground, sub-slab soil gasses may be pulled into the basement and then distributed throughout the home.
- **Exterior walls that allow air leakage** can result in outdoor air being drawn through the exterior walls, accompanied by dust, insulation particles, and microbials. This can also lead to condensation inside the wall when indoor air is pulled in to the exterior walls during the cold months.
- **Ducts made from flex duct and ductboard, located in unconditioned basements and attics** - Neither product can be cleaned easily and are associated with leakage rates of 20-40%. Installing ducts in unconditioned spaces wastes energy and can draw moisture, radon, and dust into the home from the basement and attic.
- **Commercial range hoods that move large volumes of air** - These can dangerously depressurize a home (even one that is not air-tight) and pull combustion byproducts into the house from fireplaces, furnaces, boilers, and hot water heaters.
- **Mechanical ventilation for a home’s occupants** is not required by code and is virtually never installed in Connecticut. One IAQ expert likened the situation to living inside a plastic bag - full of stale air, allergens, and chemicals “off-gassing” from building products, home furnishings, cleaning products, and personal hygiene products.
- **Commercial range hoods**, so popular in high-end homes today, often have high capacity blower motors that can cause dangerous air depressurization and the backdrafting of combustion devices.
- **Fireplaces** - Fireplaces and stoves are often installed without dedicated sources of combustion air and air-tight glass doors to eliminate the potential for backdrafting.
- **Furnaces, boilers, and water heaters** require large amounts of air for combustion but are often installed in locations with limited access to air, leading to dangerous depressurization situations.
- **Building products and finishes with volatile organic compounds (VOC)** - Urea formaldehyde is the most common and is often found in kitchen cabinets and counters, interior trim, and solid-core interior doors, to name a few. When these products are used in a new home without ventilation, significant health effects are common.

At BPC, we have incorporated the recommendations of national organizations that study these issues into the construction specifications for every home we build. We are the only builder in Connecticut qualified to build an American Lung Association Health House.

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We completed the only Health House in the state in 2000. Several of the newspaper articles that appeared at that time are available for you to read by going to our News web page.

## **Savings**

Homes built by BPC using residential building science cost less to operate and maintain than homes built to building code minimums. Savings occur in the following areas:

### **• Energy savings**

- BPC homes achieve Home Energy Rating Scores (HERS) of 90 and better. A home built to meet building code minimums scores 80. Each extra point equals a 5% increase in efficiency. Therefore, BPC homes are roughly 50% more energy efficient than a new home built to code.
- The standard construction upgrades to a BPC home permit the use of a smaller heating and cooling system than is used in a typical home of comparable size. These actually do a better job of keeping a home comfortable than larger, less efficient, and more expensive systems.
- The average annual energy savings to heat and cool a BPC built home is in excess of \$1,000.

### **• Construction savings**

- As noted under energy savings, the mechanical system of a BPC home will be small, costing less to buy (or replace, in the future) and to maintain than the larger system of comparable quality that would be installed in a typical house of comparable size.

### **• Maintenance savings**

- As noted under energy savings, the mechanical system of a BPC home can be small, costing less to buy (or replace, in the future) and to maintain than the larger system of comparable quality that would be installed in a typical house of comparable size.
- Roof overhangs of 18-24 inches (if the design permits) help to keep exterior walls dry, which increases the durability of the paint, siding and trim.
- Siding and trim are primed on all sides and installed over a drainage plane (an air space between the siding and the sheathing), which increases their durability and the life of the paint.

Exterior walls are built air-tight because air movement through the walls allows interior moisture to get into the outside walls, which can lead to condensation inside the wall. Condensation in a wall can cause insulation to become wet and ineffective, the sheathing and framing lumber to rot, and can decrease the durability of paint, siding

### **• Reduced Cleaning Requirements and Costs**

- BPC homes usually feature a variety of hard-surface floors which are easy and fast to clean.
- Air-tight homes with controlled fresh air ventilation control dust particles with a variety of effective filters.

### **• Eliminate Mitigation Costs**

- Potentially dangerous microbials, such as mold and mildew, and dust mites will not thrive in homes with waterproof foundations, air tight exterior walls, occupant ventilation, and right-sized cooling systems. Together, these measures help to maintain the relative humidity at levels that these creatures do not like.
- All BPC homes feature passive sub-slab depressurization systems to prevent the infiltration of radon from the ground. A blower motor can be added quite easily to make the system active.
- Our homes use sealed combustion heating/hot water systems, or highly efficient electric systems, to eliminate combustion byproduct issues.
- Fireplaces have a dedicated source of combustion air and air-tight glass doors to eliminate another source of combustion byproducts.
- BPC homes with attached garages feature air-tight shared walls (or detached garages) in order to isolate this source of carbon monoxide.

#### • **Reduced Medical Bills and Suffering**

- Our homes are designed and built from a holistic perspective to enhance the health and well being of the occupants, whether they suffer from allergies, asthma, multiple chemical sensitivity (MCS), or are completely healthy. A number of controlled studies have shown that these qualities result in better moods, greater productivity, fewer missed days of work and school, less medication, and less frequent trips to the doctor.

#### **Return on Investment**

Your investment in a “No Compromise” high performance home is returned quickly in maintenance and energy savings, reduced medical expenses, increased living enjoyment, and even in the resale value. Energy efficiency is becoming a big factor in the sale price of homes. The American Appraisal Institute, in a recent newsletter, noted that for every \$1 of annual energy savings, homeowners are receiving \$20 in increased resale value. BPC homes are estimated by ENERGY STAR® to save their owners \$1,000 or more in annual energy costs, which equates to a \$20,000 increase in the resale price. Another way to look at the potential resale value of your home is to consider the various requirements of potential buyers to see if your home might be more attractive than a typical home to some people.

- Would a buyer with asthma and allergy patients in the family pay more for a home that helped to relieve their symptoms without medication?
- Would a buyer concerned with mold and radon pay more for a home that was built to eliminate the risks of both?
- Would a buyer concerned with comfort pay more for a home with stable and uniform temperatures and a comfortable relative humidity year round?
- Would a buyer concerned with the environment pay more for a home that used less energy and that was built to last far longer than most homes with much less maintenance?

There are few homes on the market today in Connecticut that offer a comprehensive package of benefits similar to that offered by BPC. The unfortunate fact is that most new and remodeled homes today are not built to these standards, and homeowners are routinely offered frightening and misleading information from builders determined to protect the status quo.

Every national group that has studied home construction, including the National Association of Home Builders, the Environmental Protection Agency, and the American Lung Association concur on the basics of residential building science.

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